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TWENTY-SIXTH ANNUAL EMSA MEETING

# MYOCARDIAL ALTERATIONS IN ANIMALS FOLLOWING HIGH ALTITUDE EXPOSURE

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There is a paucity of morphological evidence, particularly at the ultrastructural level, to correlate with the physiological effects of chronic exposure to high altitude. In this study the myocardium of dogs and rabbits subjected to five months exposure at an altitude of 14,110 feet was compared to that of animals residing at sea level. The animals kept at 14,110 feet were shipped from sea level (160 feet) without acclimatization at intermediate altitudes.

The physiological parameters including the hematologic changes, pulmonary artery pressures, pulmonary artery oxygen saturations, electrocardiograph changes, right ventricular weight to body weight and right ventricular weight to total heart weight ratios observed in these animals have been reported previously (1).

The animals were necropsied at the end of the five months. The myocardium was quickly removed, cut into small pieces and immersed in 1% osmium tetroxide buffered with veronal acetate. Following fixation the tissues were dehydrated in ascending ethanol concentrations followed by propylene oxide and embedded in Epon 812. Ultrathin sections were doubly stained in uranyl acetate and lead citrate.

The fine structure of cardiac muscle from the animals exposed to high altitude exhibited marked differences from the sea level controls. The myocardium from sea level animals was characterized by mitochondria in the subsarcolemmal cytoplasm, the perinuclear region and between the myofibrils. These mitochondria were spherical or somewhat irregularly shaped with a moderately dense matrix and an abundance of cristae usually arranged in parallel array. Elements of the sarcoplasmic reticulum were distributed within the myofibrils. The myofibrils had the usual striated appearance. Intercalated discs composed of the plasma membranes of two adjacent cells were frequently observed in the normal cardiac muscle.

The myocardium of the animals kept at 14,110 feet had markedly enlarged, pale mitochondria. The mitochondrial cristae were reduced in number and irregularly arranged. In some instances, cristae were degenerated and formed membranous inclusions within the mitochondrial matrix. Occasionally clusters of fused, degenerating mitochondria were observed. In many regions the sarcoplasmic reticulum appeared greatly dilated forming large vacuolated cisternae between the myofibrils. There was a moderate increase in the number of lipid droplets. These were usually associated with the mitochondria between the myofibrils. Large accumulations of glycogen were found in the subsarcolemmal space and among the myofibrils. The myofibrils appeared normal with the exception of an occasional separation between the myofilaments. These changes were focal in nature and apparently randomly distributed.

We interpret these changes to result from the hypoxia occurring at 14,110 feet.

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(1) Dean, W. D., J. A. Vogel, G. W. Bishop, L. A. Frics, M. B. Bischoff, and T. J. Bucci. Fed. Proc. 27, 284 (1968).

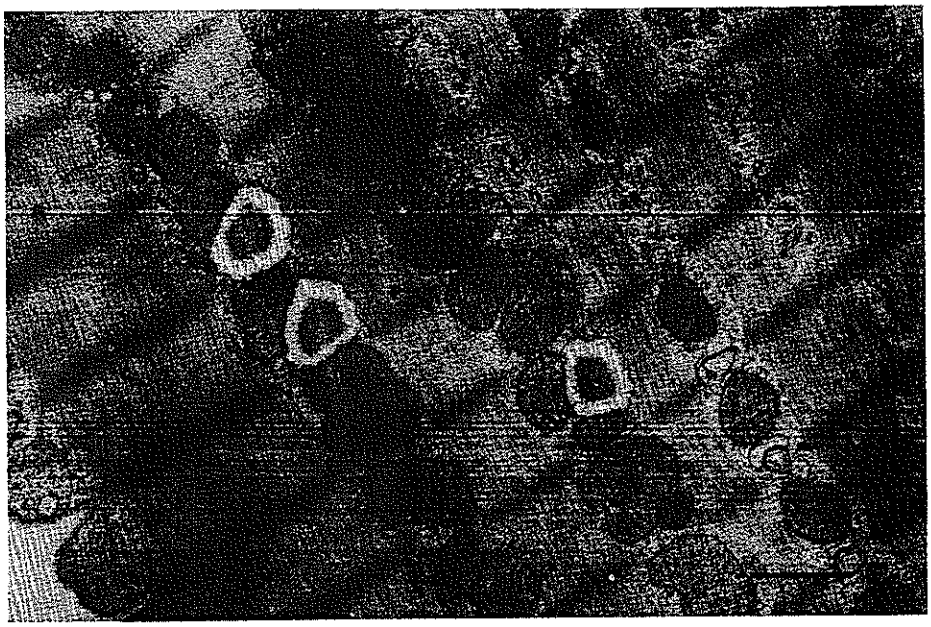

Figure 1. Right ventricular myocardium from a dog exposed to 14,110 feet. Lipid droplets are associated with apparently normal mitochondria within this focus. There is an occasional separation between the myofilaments. Glycogen is abundant.

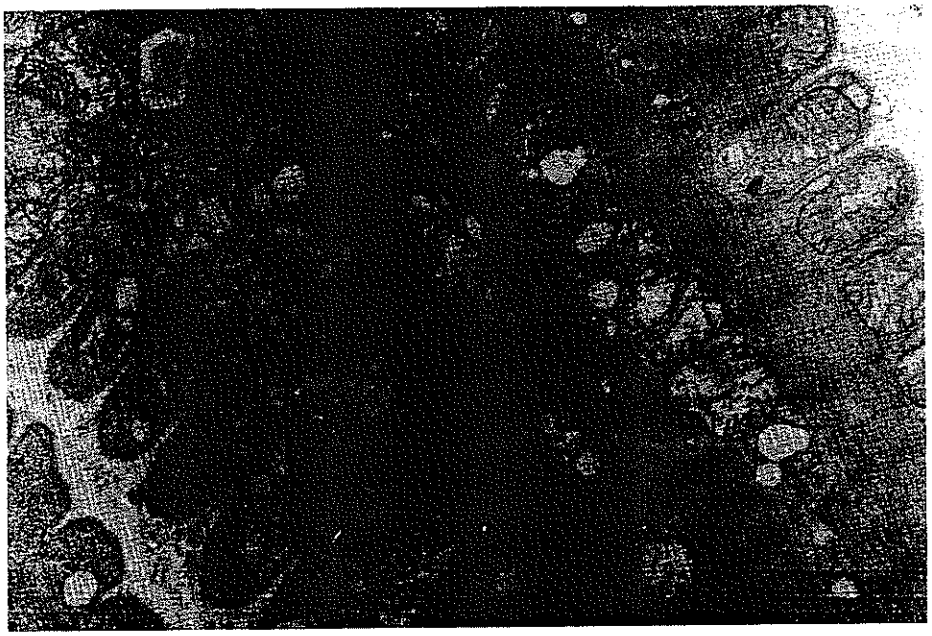

Figure 2. Right ventricular myocardium from a dog kept at 14,110 feet. Mitochondria in this focus are swollen and pale with the cristae reduced in number and irregularly arranged. Glycogen is found in the subsarcolemmal cytoplasm and among the myofibrils.